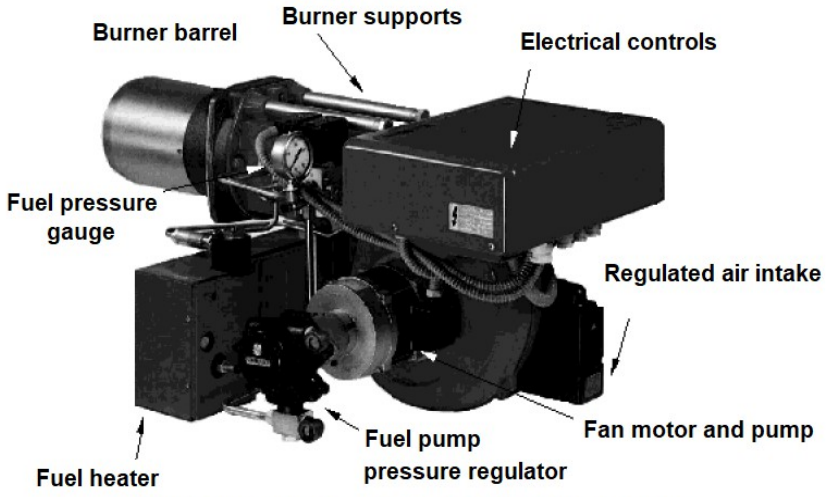
CHAPTER 25: DATA ON BURNERS



MECHANICALLY PRESSURIZED LIQUID FUEL BURNER

Recommended temperatures for different types of atomization:

Mechanical atomization.....approx. 135°C (275°F) to 145°C (293°F) in heavy fuel oil.

approx. 115°C (239°F) to 125°C (257°F) in heating fuel oil.

Steam atomization.....approx. 95°C (203°F) to 110°C (230°F) in heavy fuel oil.

approx. 75°C (167°F) to 90°C (194°F) in heating fuel oil.

Air atomization.....approx. 110°C (230°F) to 125°C (275°F) in heavy fuel oil.

approx. 90°C (194°F) to 115°C (239°F) in Heating Oil.

Cup Atomization:..... approx. 90°C (194°F) to 100°C (212°F) in Heavy Oil.

Approx. 60°C (140°F) to 70°C (158°F) in Heating Oil.

These values vary according to local burner conditions (burner type, furnace, operation, etc.).

Viscosity values (approx.) for atomization according to burner type:
SSU = Seybolt Universal Seconds

300-150 SSU: Large steam atomizing burners.

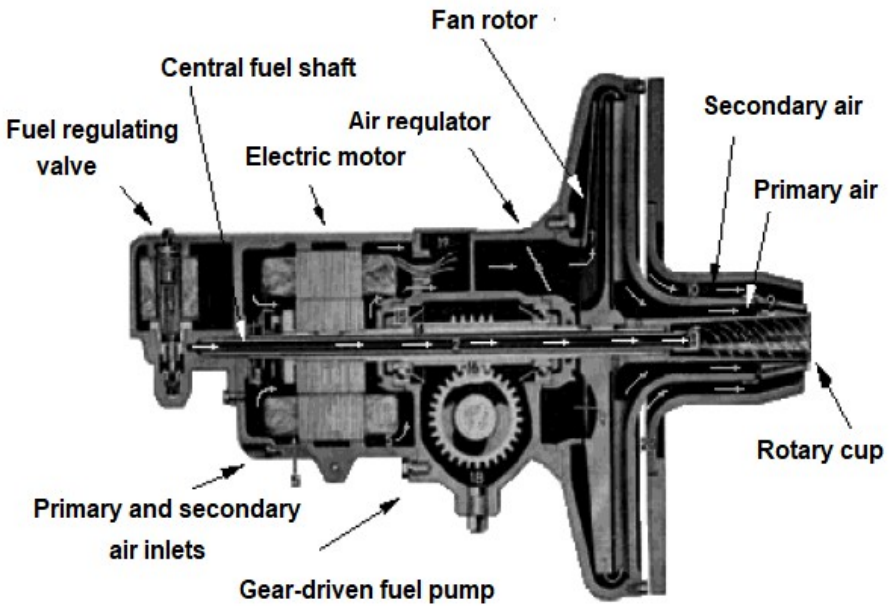
100-150 SSU: Small steam or air atomizing burners, rotary cups.

100-70 SSU: Large mechanical atomizing burners.

70-36 SSU: Medium and small mechanical atomizing burners with nozzles (preferably for heavy oil).

With standard nozzles, fuel oil operates at very high temperatures, and atomization is generally poor.

Up to 36 SSU: Mechanical atomization with standard nozzles (heating fuel oil, diesel oil, and gas oil).



ROTARY CUP BURNER FOR LIQUID FUELS

Atomizing nozzles or nozzles (in mechanical atomization).

Their characteristics are generally expressed as follows:

Capacity

in common nozzles (mechanical atomization burners) is expressed in USG.

Example:
10 USG, this means the hourly capacity in US gallons (3.78 liters per gallon), but at a pressure of 100 PSI (pounds per square inch) (approximately 7 kg/cm²) with No. 2 fuel oil at 60°F (equivalent to diesel fuel at 15.5°C).

This capacity then varies according to the fuel pressure, temperature, and type of fuel in the burner.

Contrary to what one might think, with more viscous fuels, despite common sense suggesting they would pass through with greater difficulty (per kg/h), the same nozzle at the same pressure passes more heavy fuel oil (kg/h) than heating oil, diesel, or gas oil (kg/h).

In other burners, the nozzles (flashes) and their atomization (turbulence) chambers are indicated by a number and letters, which each manufacturer specifies in their regulations.

The capacities of the atomizing nozzles vary in relation to the square root of the pressures: if at pressure P1 the burner has a flow rate of V1 U.S.G., at pressure P2 it will be V2 = V1 x Square root of P2/P1.

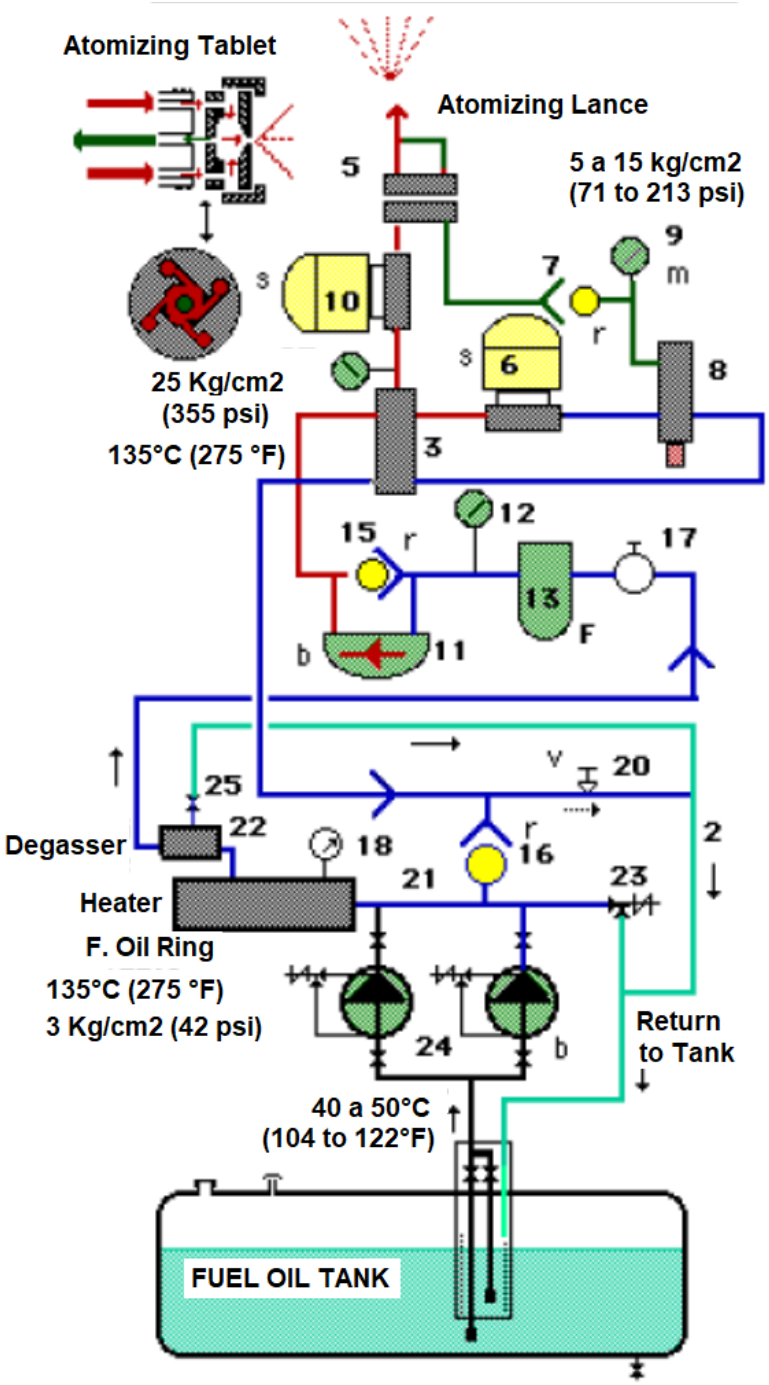
Nozzle type according to fuel:

There are special nozzles for heavy fuels. They are marked with the letters H.O. (Heavy Oil) and a number, which indicates the most suitable operating pressure for that nozzle. Common nozzles do not have this pressure rating.

Example:

H.O. 430 is a nozzle for fuel oil that should operate at 430 PSI (pounds per square inch) or 30 kg/cm².

The standard values are H.O. 200 and 430.
These nozzles are made with "harder" materials to work with fuels containing more "impurities."



10 6 solenoids

8 return regulator

3 safety relief and cut-off valve

11 high-pressure pump

24 low-pressure pumps

7 15 16 check valve

20 manual return regulator

5 lance coupling

23 relief valve

22 degasser

9 16 25 pressure gauges

25 gas return valve

13 filter

17 valve

These nozzles are tested at the marked pressure (200 PSI, 430 PSI, etc. lb/#) with a "heavy" fuel at a viscosity of 66-77 SSU, with an API gravity of 34-36 at 60°F (15.5°C).

They are tested to verify their flow rate at the working pressure indicated in the tables, although the flow rate printed on the U.S.G. --- is the nominal flow rate tested at 100 pounds per square inch (7 kg/cm²), with a viscosity of 34-36 SSU and an API gravity between 32-38 at 60°F (15.5°C), corresponding to a No. 2 fuel oil (Gas Oil).

The atomizing pads, formed by flat surfaces between the swirl chamber and the pad, must be ground periodically (using fine grinding compound and, alternatively, a marble slab or thick, flat glass) to ensure that both surfaces make perfect contact (testing with Prussian blue).

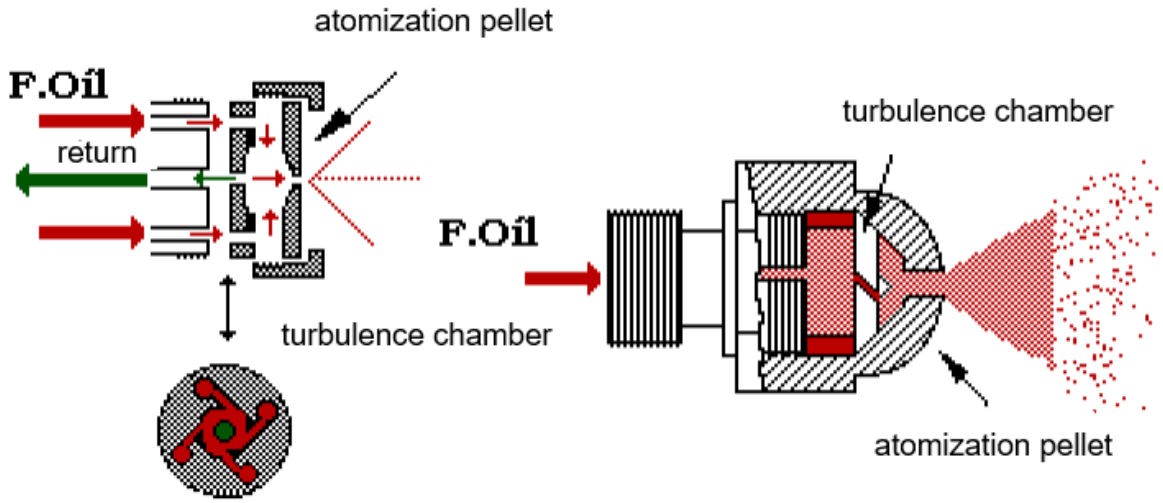
If these flat surfaces do not seat correctly, fuel leaks outside the grooves in the swirl chamber will prevent the proper rotational action, resulting in inadequate atomization.

Furthermore, the material used to manufacture these components must be refractory steel to prevent deformation at the high temperatures they endure (flat surfaces tend to deform at high temperatures but flatten again at low temperatures, which "deceives" the operator when testing them with Prussian blue).

This is the sketch on the left of the following drawing (a mechanical atomizing nozzle with flow control via fuel return, designed to maintain the fuel velocity in the torsion chamber, where the fuel acquires the centrifugal spin that allows it to exit through the nozzle's orifice in atomized form.

Each "droplet" travels in a straight line; only the primary and secondary air change trajectory.

The flow rate varies due to the return flow, which lowers the atomization pressure but not the atomization quality, up to a certain limit).



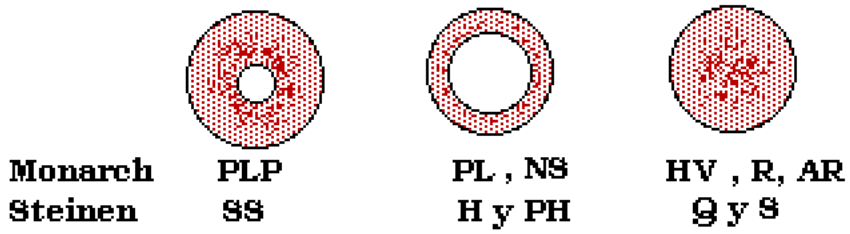
Burner nozzle and turbulence chamber. Most common burner nozzle.

Spray cone shape: Nozzles are designed so that the atomization cone shape is suitable for the type of furnace in which they will be used. These shapes can be a simple cone, a cone with a higher concentration of fuel in the center, a cone with a hollow center, a ring, etc.

The shape is indicated by letters that each manufacturer uses according to their product: for example: R (center-loaded cone), NS (hollow center cone), AR (slightly less center-loaded cone), S (highly center-loaded cone), H (even ring), PH (thin ring), SS (thick ring), Q (even cone), etc., all related to the manufacturer's code.

The atomization angle is the angle formed by the cone; generally, the heavier the fuel, the greater the atomization angle required.

When ordering the nozzle, the following is indicated: The brand (Steinen, Monarch, etc.), the capacity in U.S.G. (number), the type of atomization cone (R or other) and the atomization angle (the most common are 45º, 60º, 90º, etc.) and if it is H.O. (Heavy Oil, i.e., for heavy fuel) plus the working pressure a number (420, 300, 200 lb/#).



SHAPE OF THE ATOMIZATION CONE ACCORDING TO DESIGNATIONS
Working pressures in the most common burners (with mechanical nozzles).

With heavy fuel oil, the working pressure at the nozzle should be high, as higher pressure generally results in better atomization of a heavy fuel.

If the nozzle doesn't specify a working pressure, a normal pressure can be between 22 kg/cm² and 30 kg/cm², slightly lower for heating fuel oil.

With diesel and gas oil, pressures tend to be lower; 7 to 15 kg/cm² is generally sufficient. Be careful not to increase the pressure too much, as this increases the fuel flow and can lead to over-ignition.

In burners with steam or compressed air atomization, the fuel pressure at the nozzle is generally lower, reaching a maximum of 15 kg/cm² (213 PSI), with a typical range between 4 kg/cm² (47 PSI) and 12 kg/cm² (170 PSI).

The atomizing steam pressure depends on the nozzle type. In some, it is slightly higher than the fuel pressure, while in others, it is fixed at a "purge" pressure, which might be, for example, between 2.5 kg/cm² (35.5 PSI) and 3.5 kg/cm² (49.8 PSI).

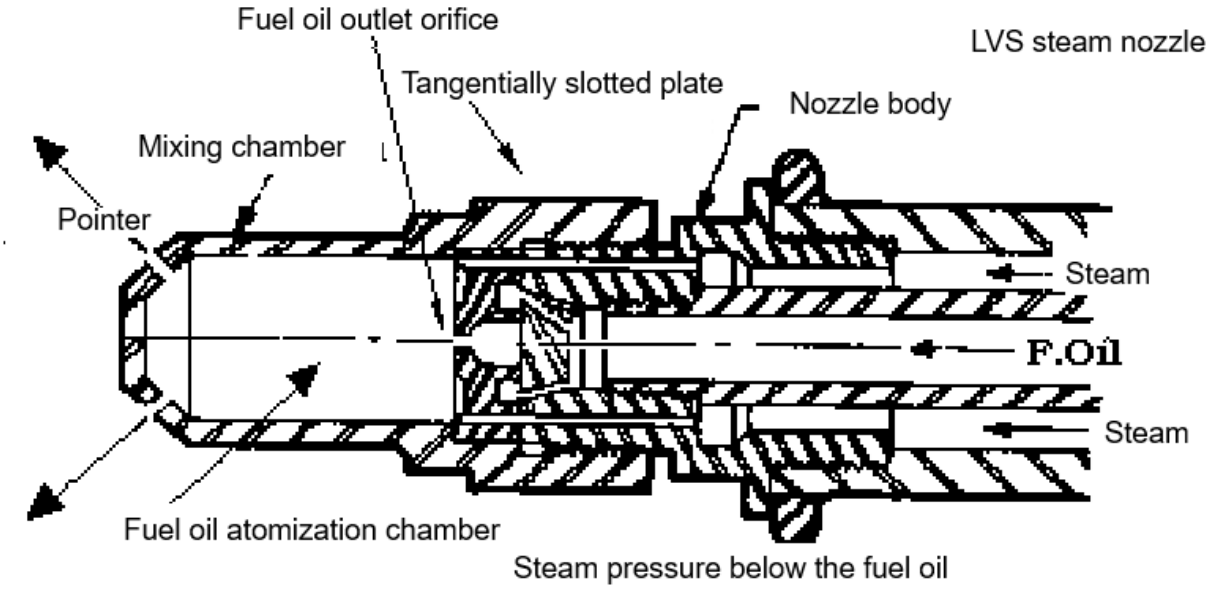
Remember that this steam must be dry and saturated; it must not contain any water droplets or water at all. A good water separator must be installed before the steam pressure regulator enters the burner.

One way to know if we are overheating is to measure the chimney temperature; if the gases are hotter than indicated by the manufacturer or by the type of boiler, we are overheating (unless the boiler is dirty with soot or encrusted, or a gas partition is "perforated" in "short-circuit").

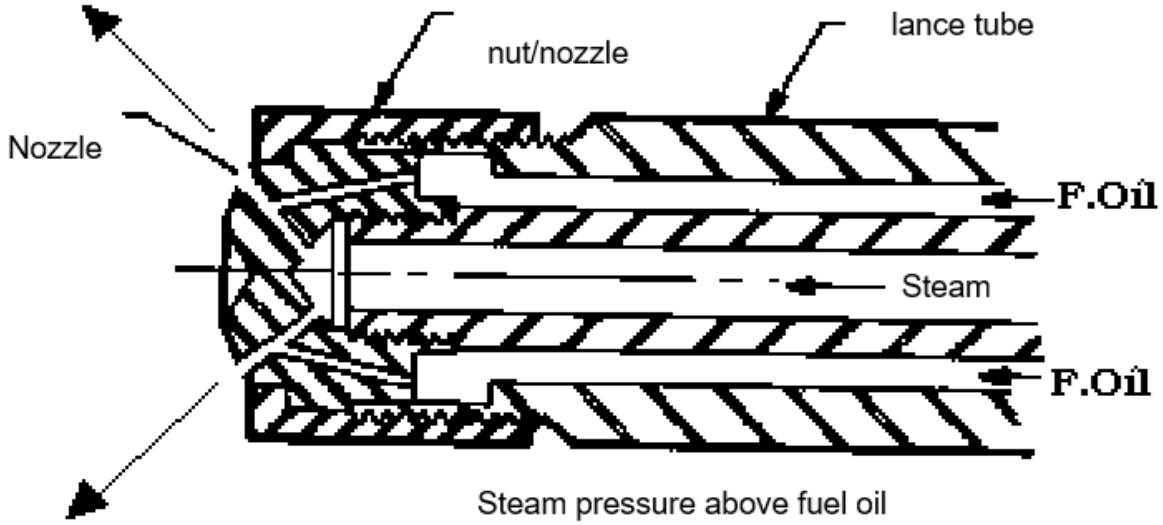
STEAM ATOMIZATION, MOST COMMON LANCES:

The LVS steam atomizing lance (or possibly air) uses steam to "carry" the atomized fuel oil into a chamber (where simple mechanical atomization occurs). Therefore, the steam does not need to be at a pressure higher than the fuel oil pressure (generally between 2 and 3 kg/cm²).

This type of lance can operate with compressed air, as in the case of startup (although a smaller capacity lance or a mechanical atomizing lance is usually used).



The Y-Jet steam atomizing lance, using steam at a higher pressure than the fuel oil, "carries" the fuel oil and atomizes it directly in the combustion chamber.



Y-Jet steam nozzle

The steam pressure is generally 1.5 to 2 kg/cm² above the fuel oil pressure, which varies between 3 and 12 kg/cm².

This system does not function properly with compressed air. For this reason, a mechanical atomizing lance will be used for startup with a cold boiler.